



Ethnobotanical study of some medicinal species of the Mauritanian flora

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IN MAURITANIA, herbal medicine is an integral part of the culture of the society. However, ethno-medicinal data remain scarce and fragmentary. In this work, the ethno-medicinal knowledge in five regions inhabited mainly by two Mauritanian ethnic groups: the "Maures" and the "Peulhs" was explored. These regions present the climatic stages of the country from hyper-arid to Sahelo-Saharan. This suggests that the use of plants by the population in their health care will depend on their presence in the environment. Our methodology consists of a diagnosis of the current situation of this herbal medicine through an ethno-medical survey of healers in the regions of Tiris Zemmour, Inchiri, Adrar (North), Trarza and Brakna (South West). seventy-six informants were enrolled in this study. Results showed that (93.42%) of the informants belong to the 'Maures' community and that women (64.45%) are more involved in this practice. The majority of traditional healers are married (97.38%). The older people and the least educated are the most present in the profession. The ethnobotanical study made it possible to inventory 56 medicinal species, used in phytotherapy, belonging to 25 families. The most cited are *Ziziphus lotus*, *Ziziphus mauritiana*, *Vachellia tortilis*, *Adansonia digitata*, *Gymnosporia senegalensis*, and *Senegalia senegal*. The modes of administration exhibit that the aerial part is the most used (53.50%). The majority of remedies are prepared as infusions (48%) and maceration (22%). The majority of medicines are administered orally (99.77%). Most of medicinal species in the five regions studied are prescribed for diseases of the digestive tract (53.50%). No difference has been observed in the use of this medicine among ethnic groups. these data will serve as a basis for researchers and as a reference for establishing action plans for the conservation of Mauritanian flora in general and traditional medicine in particular.

Keywords: Ethnobotanical study, Medicinal plants, Traditional healer, Mauritania.

Introduction

Traditional medicine includes all the knowledge, skills, and practices based on the conceptions and experiments of different cultures, whether explicable or unfounded, used to maintain health and to prevent, diagnose, and treat physical and mental illness (Dahmane et al., 2023). Herbal medicine is exceedingly used in the world, especially in underdeveloped countries. Humans have always considered plants as a source of therapeutic medicines, particularly in rural areas (Dahmane et al., 2023; Ginko et al., 2023; Irfan et al., 2023; Tabuti et al., 2003; Thirumalai et al., 2009). This plant-based medicine is still well-preserved by many communities (Ferrier et al., 2015; Heinrich & Gibbons, 2001; Mirzaman et al., 2023). In addition, it also offers significant economic benefits. Sales of herbal medicines in the United States amounted to \$15.5 billion (Nguyen et al., 2020). The precise value of global markets for herbal products is difficult to estimate, but it is

clear that this industry is growing rapidly at over 4% per year (Saroya, 2011). In this context, there has been a noticeable revival of interest in these traditional medicines (Bonokwane et al., 2022). The World Health Organization (WHO) has recognized the importance of medicinal plants as therapeutic resources (Belhaj & Zidane, 2023). As a result, it encourages the archiving and valorization of knowledge of traditionally used plants (Alalwan et al., 2019). This is to expand the scope of herbal medicine and the development of new medicines (Khadim et al., 2023).

Africa has vast plant resources (Dibong et al., 2011). The vast majority of rural populations on our continent, where over 80% rely on it for healthcare due to poverty and the high cost of modern medicines (Jiofack et al., 2009; Ngbolua et al., 2021). Traditional healers are found in most indigenous rural societies. They usually enjoy a high social status in their communities. They therefore usually have considerable influence on local health practices. This may be of interest to

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explore the possibilities of engaging them in supporting primary health care (Belhaj & Zidane, 2023). In Africa, this knowledge is transmitted orally from generation to generation without the aid of a writing system, as many traditional healers do not keep written records (Kaido et al., 1997).

Ethno-botanical and ethno-pharmacological study is the first step in the identification and conservation of medicinal plants (Mahwasane et al., 2013; Süntar, 2020). Recently, many countries have become more interested in the study of medicinal plants (Nesrine et al., 2022). Contemporary science has recognized their active action and has included in modern pharmacotherapy a series of plant-based medicines known to ancient civilizations and used over the millennia. The knowledge of the development of ideas related to the use of medicinal plants as well as the evolution of awareness have increased the ability of pharmacists and doctors to respond to the challenges that have emerged with the spread of professional services in the facilitation of human life (Petrovska, 2012). The development of new drugs requires the integration of several sciences such as chemistry, pharmacology, and botany (Benarba, 2016). The practice of traditional medicine dates back to an early period in the country's history.

Mauritania's flora is poor compared with the rest of the sub-region, with an estimated 1400 species, 88 of which are widely used in traditional medicine in Mauritania's various phytogeographical regions (Ould Mohamed Vall, 2009; Vall et al., 2011, 2015). Herbal medicine is an integral part of the

culture of the country's inhabitants. Thus, it represents a socio-cultural heritage within the communities. However, there is little information on the flora of this country compared to those of the sub-region.

We can note works, that remain incomplete and fragmentary on ethnobotanical studies in Mauritania; these are essentially the thesis of Yebouk (2021) and the publications of Ould Mohamed vall (2009), Vall et al. (2011, 2015). This study aims to provide an up-to-date inventory of Mauritania's flora, as well as the methodological aspects of the use of medicinal plants by the various ethnic groups in Mauritania.

Materials and Methods

1. Study area

Mauritania is a country in West Africa with an area of 1,030,700 km². It borders Algeria to the northeast, Morocco to the north, Mali to the east and southeast, and Senegal to the southwest. The climate is generally very hot and dry desert. The people are multi-ethnic and multicultural (Maures, Peulh, Wolof, and Soninke).

The survey was conducted in five regions of Mauritania (Fig. 1): Tiris Zemmour, Inchiri, Adrar (North), Trarza and Brakna (Southwest). The north of the country (Tiris Zemmour, Inchiri, Adrar) is mainly inhabited by the Arab-Berber community. As for the southwestern part (Trarza and Brakna), both ethnic components (Arab-Berbers and Black Mauritians) are found there.

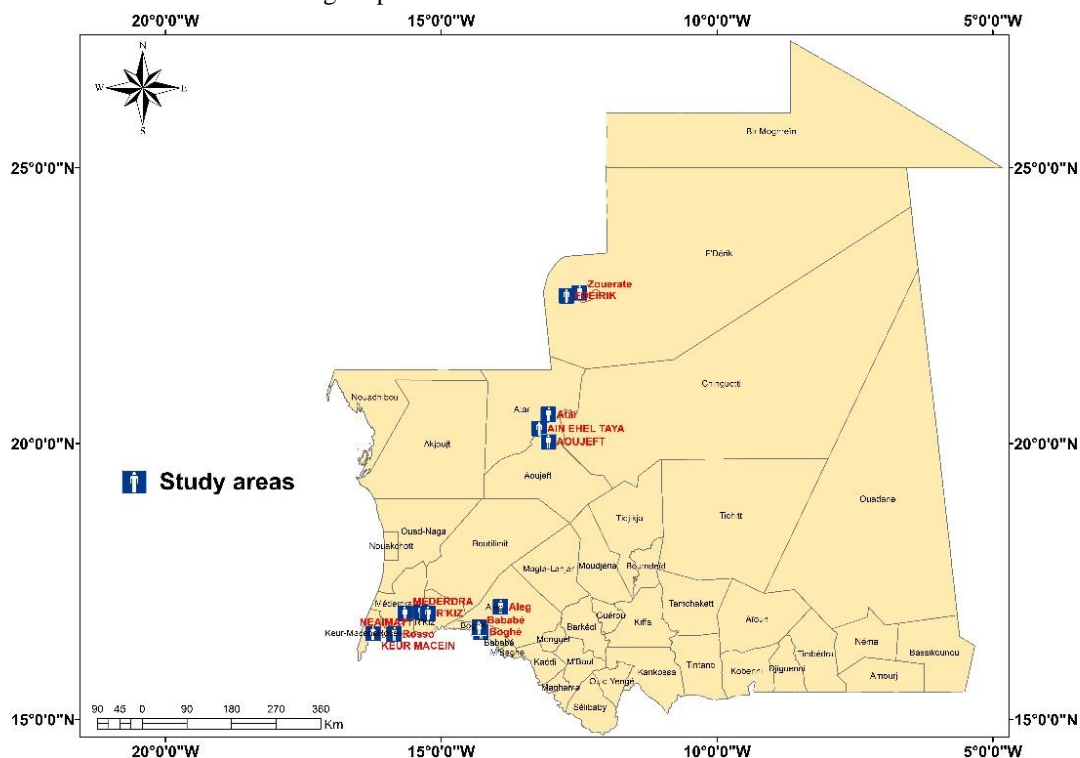


Fig. 1. Map of the study area for the location of the Wilaya surveyed (Tiris Zemmour, Inchiri, Adrar, Trarza, and Brakna).

2. Data collection

The survey targeted traditional healers in different villages and localities. Our approach consisted of interviews on medicinal plants and their use, using questionnaires according to Gedif & Hahn (2003) and Amiguet et al. (2005). The information requested is articulated around two points below:

- The first point concerns the informant: gender, age, ethnicity, marital status, education, and region.
- The second point deals with the plant material: species, part used, therapeutic use, preparation, and administration methods.

The interviews were conducted in 'Pulaar' and 'Hassaniya' in the Brakna and Trarza regions and in 'Hassaniya' in the remaining four regions (Tiris Zemmour, Inchiri, and Adrar). The survey was carried out over one year. The plateau of questionnaire information was reached after 76 sheets.

The nomenclature of the plant species and the taxonomic system was carried out concerning the Tropicos® database (Tropicos 2017).

3. Data analysis

After The Survey, all data were entered into an Excel sheet. The collected data were statistically analyzed and the phytotherapeutic importance of each species was assessed by calculating indices of quantitative value such as, the frequency of citation (FC), the relative frequency of citation (RFC), and the family importance value (FIV).

Frequency of citation (FC)

FC is the number of informants who mentioned the species

Relative frequency of citation (RFC)

The RFC was used to determine the degree of consensus among informants on which trees or shrubs were used for each "species use" category.

The RFC was calculated as follows:

$$RFC = (FC) / N \quad (0 < RFC < 1)$$

where FC is the number of informants who mentioned the species and N is the total number of informants (Khalid et al., 2022)

Family importance value (FIV)

The FIV recognizes the importance of plant families. It was calculated using the formula (Molares & Ladio, 2009):

$FIV = RFC / N_s$, where N_s is the total number of species in each family.

Results and Discussion

An ethnobotanical survey was conducted in targeted regions representative of the distribution of ethnicities and the floral diversity imposed by the climatic gradient in the country.

Socio-demographic data

The survey was conducted among healers in the three northern regions (Tiris Zemmour, Inchiri, and

Adrar) and two southwestern regions (Trarza and Brakna). A total of 76 traditional informants were interviewed. This number allowed us to reach the plateau. This is defined by the repetition of information in the questionnaires. The results obtained showed a difference according to gender, age, ethnicity, etc.

Distribution by ethnicity

The results revealed that out of the 76 healers questioned, the majority belong to the 'Maure' community (93.42%). The 'Peulh' community came second with 6.57% (Fig. 2a). The 'Peulh' society is characterized by rituals at the time of harvesting their samples. We note that 50% of this community only harvests on specific days of the week. In addition, they access the plant from a specific direction by reciting Koranic verses. This observed difference is due to the representativeness of these ethnic groups in the regions of our study. Indeed, regionally, the distribution of ethnic groups differs from the northern region (Tiris Zemmour, Inchiri, and Adrar) to the southwestern region (Brakna and Trarza) (Fig. 2b). We note that the 'Maure' constitute 100% of our sample in the regions of Tiris Zemmour, Inchiri, and Adrar. In Brakna and Trarza, the percentage of 'Peulh' is 23.52% and 3.44% respectively.

Distribution by gender

Our study shows that the two sexes engage in this practice differently. Indeed, women predominate with 64.45% against 35.52% for men (Fig. 3).

This superiority of women seems to be linked to their omnipresence in the home and their vigilance, as well as the scarcity of healthcare centers in the vicinity. These results are in agreement with those of (Arezki et al., 2010; Bencheikh et al., 2021; Eddouks et al., 2002; El Hafian et al., 2014; Mechaala et al., 2022; Salhi et al., 2010) Indeed, it is women, in particular rural women, who provide healthcare for their families in case of illness. In contrast, other studies in Togo (Damintoti Karou et al. 2011; Gbekley et al. 2015), Côte d'Ivoire (Gnagne et al., 2017), and Ghana (Essandoh et al., 2023) have shown that men are the most involved in this practice. This difference could be socio-cultural. Women are generally preferred in sales roles (Addo-Fordjour et al. 2013; Torres-Aviles et al. 2016).

Distribution by marital status

Figure 4 demonstrates that the majority of healers are married (97.38%). Single healers are not significant (2.63%). These results support the above explanation suggesting that this profession is an economic source for some families. Some authors suggest that the proximity of parents to their children, to help them, forces them to practice this

profession professionally (Dougnon et al. 2017; El Hilah et al. 2015).

Age distribution

The practice of traditional medicine is present among both old and young people. However, the elderly still predominantly use it. People over 50 years of age represent 53%, followed by the age group [41-50] which represents 29%. The age groups [31-40] and [20-30] each account for 14% and 4% respectively (Fig. 5).

This gradual decrease with age reflects the reluctance of younger people. Manuel et al. (2020) have shown that this traditional knowledge, held by the older generation, is transmitted by practice often within the same family. For Mokgobi (2014) and Mechaala et al. (2022), older people are more selective in transmitting this knowledge within the family. Our results suggested that this knowledge is threatened by disappearance if it is not conserved and safeguarded (Anyinam, 1995; Benkhniqne et al., 2015; Mehdioui & Kahouadji, 2007).

Informants level of education

The survey revealed that a considerable percentage of the healers (76%) in its five regions have not attended modern education.

These traditional healers limited themselves to the Koranic school. The remaining 23.67% attended modern education with 6.57% at primary and 17.1% at secondary level (Fig. 6a). These results made manifest that the reluctance of young people is probably due to their intellectual level. Figure 6b shows that this predominance of traditional practitioners who have not undergone modern education is noted in all the regions studied. It varies from 56.25% (Adrar) to 94.11% (Brakna).

Species surveyed

The ethnobotanical survey made it possible to inventory 56 medicinal species belonging to 25 botanical families (Tab. 1). Of the 25 families encountered (Fig. 7), two families clearly dominate the use pattern, namely Fabaceae (16 species) and Malvaceae (7 species). Similar studies by Mhlongo and Van Wyk (2019) showed that Fabaceae are the most dominant in traditional medicine. However, Yaseen et al. (2015) showed a predominance of Amaranthaceae and Cucurbitaceae, in the Thar Desert (Sindh) of Pakistan and they explain the dominance of Amaranthaceae by the arid-desert habitat and its xerophilic conditions. This is in contrast to our results where only two species were recorded in each of these two families.

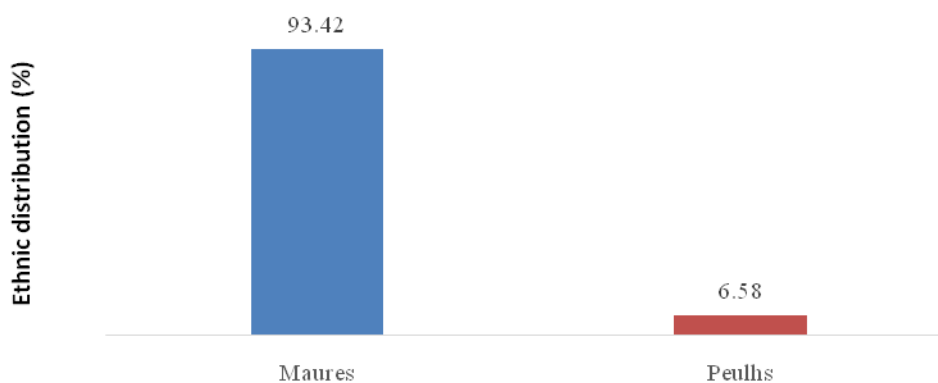


Fig. 2. (a) Distribution of healers by ethnic group.

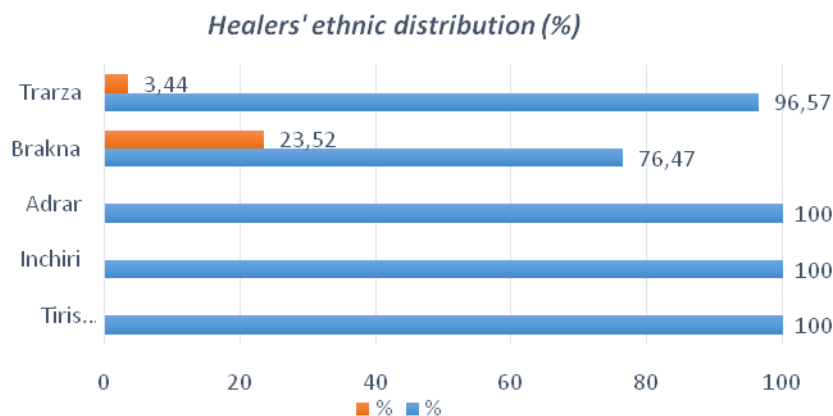


Fig. 2. (b) Ethnic distribution of healers according to the five regions (Tiris Zemmour, Inchiri, Adrar, Brakna, and Trarza).

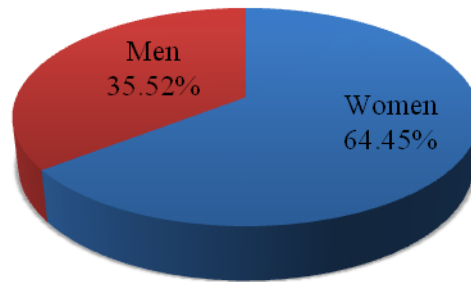


Fig. 3. Distribution of healers by gender (men, women).

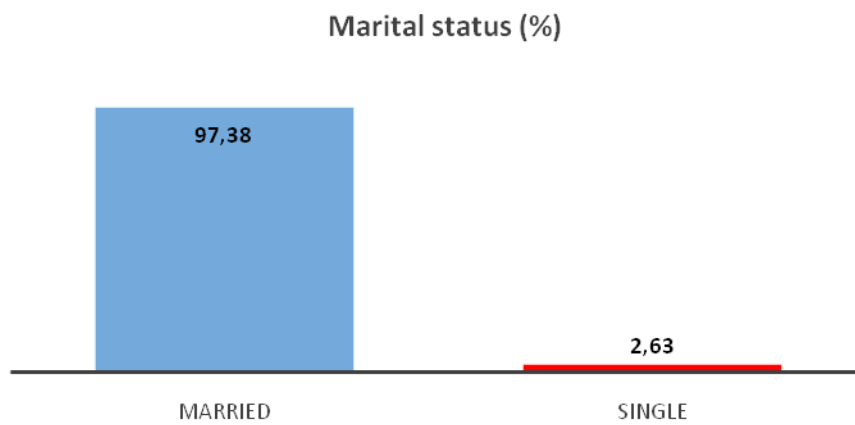


Fig. 4. Representation of the family situation of healers in the five regions (Tiris Zemmour, Inchiri, Adrar, Brakna, and Trarza).

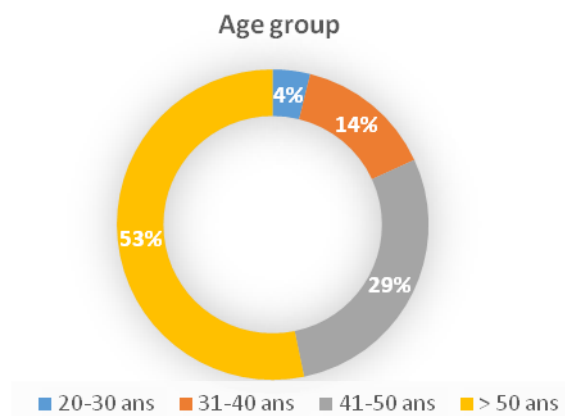


Fig. 5. Distribution of healers by age group [20-30], [31-40], [41-50], [>50].

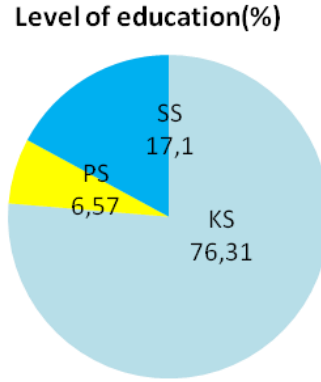


Fig. 6. (a) Overall frequency by school level.
 KS: Koranic school; PS: primary school; SS: secondary school

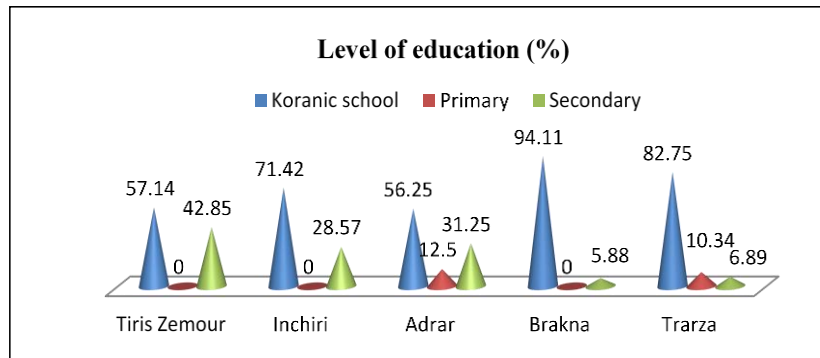


Fig. 6. (b) Distribution of education levels by region (Tiris Zemmour, Inchiri, Adrar, Brakna, and Trarza).

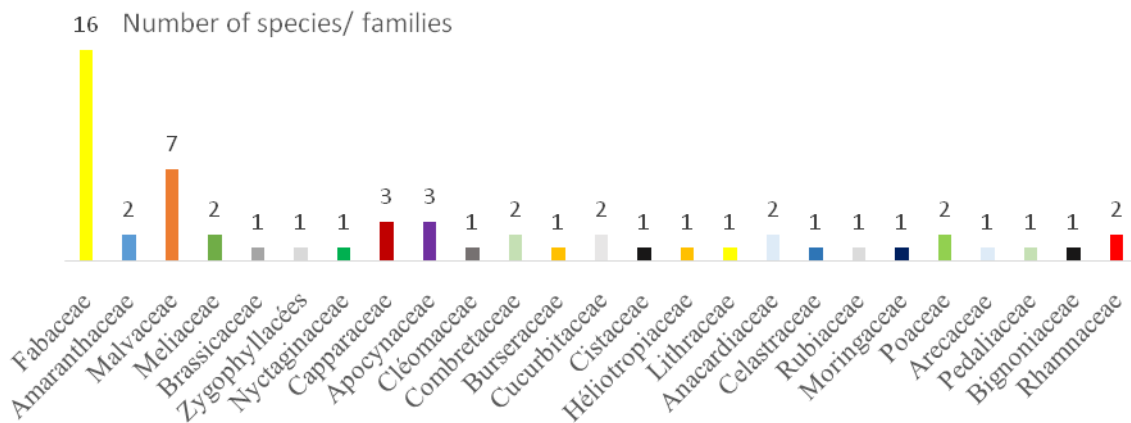


Fig. 7. Number of species inventoried by family.

Table 1. Ethnomedical uses of plant species in the Tiris Zemmour, Inchiri, Adrar, Brakna and Trarza regions (Hassaniya: language spoken by the Maure community; Pulaar: language spoken by the Fulani community).

| Plant families and Botanical names | Voucher No. | Vernacular name | Parts Used | Condition | Disease category | Mode of preparation | Mode of administration |
|---|--------------|-------------------|----------------|-----------|--|-------------------------------------|------------------------|
| | | Hassaniya | Pulaar | | | | |
| Amaranthaceae | | | | | | | |
| <i>Achyranthes aspera</i> L. | HNM 1579 | Beitlabde | L | Dry | Hypertension ; gastrointestinal | Infusion | Oral |
| <i>Aerva javanica</i> Juss. | HNM 1589 | Temayya | L | Dry | Toothache; migraine | Infusion Decoction Maceration | Oral |
| Anacardiaceae | | | | | | | |
| <i>Mangifera indica</i> L. | Exotic plant | Mangou | L, F, S | Fresh | Body pain ; Hypotension | Nature Decoction | Oral |
| <i>Sclerocary birrea</i> Hochst. | HNM 1535 | Dembou | L, F, S | Dry Fresh | Gastrointestinal ; Dysentery | Infusion Nature | Oral |
| Apocynaceae | | | | | | | |
| <i>Calotropis procera</i> (Aiton) Dryand. | HNM 2507 | Tourje | L, F, La | Dry | Bone and joint pain | Cataplasme Infusion | Oral, Massage |
| <i>Leptadenia lanceolata</i> subsp. <i>lanceolata</i> | HNM 1548 | Idar | L | Dry | Stomachache | Infusion | Oral |
| <i>Leptadenia pyrotechnica</i> (Forsk.) Decne. | HNM 1585 | TitariktAssaba ye | L, La, B, F, R | Dry | Jaundice; Constipation | Infusion Cataplasma Decoction | Oral, Massage |
| Areaceae | | | | | | | |
| <i>Phoenix dactylifera</i> L. | Exotic plant | T'mar | F | Fresh | Gastrointestinal disorders | Infusion | Oral |
| Bignoniaceae | | | | | | | |
| <i>Stereospermum kunthianum</i> Cham. | HNM 1537 | Varkake | R | Dry | Coughing; Stomach pains | Decoction | Oral |
| Brassicaceae | | | | | | | |
| <i>Anastatica hierochuntica</i> L. | HNM 2515 | El kemche | L | Dry | Diabetes; Hypertension | Infusion | Oral |
| Burseraceae | | | | | | | |
| <i>Commiphora africana</i> (A. Rich.) Engl | HNM 2408 | Adriss | L, E, W | Dry | Toothache; Weakness; Bone and joint pain | Infusion Decoction | Oral |
| Capparaceae | | | | | | | |
| <i>Boscia senegalensis</i> Lam. | HNM 2511 | Eyzine | L, S | Dry | Diabetes; Stomachache; Aphrodisiac | Infusion | Oral |

| | | | | | | | | |
|--|----------|-------------|----------------|----------|------------|--|---------------------------------|------|
| <i>Capparis decidua</i> (Forssk.) Edgew. | HNM 2512 | Eygnine | Guidjili Guumi | L, E | Dry | Constipation | Infusion Decoction | Oral |
| <i>Maerua crassifolia</i> Forskal. | HNM 2513 | Atil | Sogui | L, S | Dry, Fresh | Rheumatism; Loss of appetite | Nature Infusion Decoction | Oral |
| Celastraceae | | | | | | | | |
| <i>Gymnosporia senegalensis</i> Loes. | HNM 2410 | Eych | Gyalgoti | L | Dry | Dysentery; intestinal worms | Infusion Decoction | Oral |
| Cistaceae | | | | | | | | |
| <i>Helianthemum lippii</i> (L.) Dum. Cours. | HNM 1583 | Tirvasse | | L | Dry | Inflammation | Infusion Maceration | Oral |
| Cleomaceae | | | | | | | | |
| <i>Heliotropium ramosissimum</i> Sieber ex DC. | HNM 1581 | Limkhaynze | | L | Dry | Inflammation | Cataplasme | Oral |
| Combretaceae | | | | | | | | |
| <i>Combretum aculeatum</i> Vent. | HNM 1541 | Ikik | Lawnande | L, R | Dry | Haemorrhoids; Body weakness | Decoction Infusion | Oral |
| <i>Combretum glutinosum</i> Perr. ex DC | HNM 2406 | Tikiffit | Doki | L, S | Dry | Menstrual disorders ; Constipation ; Diabetes ; Anaemia; Hepatitis | Infusion Cataplasme | Oral |
| Cucurbitaceae | | | | | | | | |
| <i>Citrullus colocynthis</i> (L.) Schrad. | HNM 1582 | Hdejilmar | Denenale | L, F, La | Dry | Menstrual disorders; Diarrhea; Ashma; Anaemia; Constipation | Infusion Maceration | Oral |
| <i>Momordica balsamina</i> L. | HNM 2407 | Tounbahrala | Demba harire | F | Fresh | Inflammation | Nature | Oral |
| Fabaceae | | | | | | | | |
| <i>Bathinia rufescens</i> Lam. | HNM 1547 | Ndirn/Ndirr | Namaadi | L | Dry | Diuretic; fever | Infusion Maceration | Oral |
| <i>Dalbergia melanoxylon</i> Guill. & Perr. | HNM 1530 | Sanghou | Dalamban | Fl, L | Dry | Migraine ; Cough; Hernia | Infusion | Oral |
| <i>Faidherbia albida</i> (Delile) A. Chev. | HNM 1531 | Avrar | Ccaski | L, S, Se | Dry | Eye inflammation ; toothache; ulcers | Infusion | Oral |
| <i>Indigofera senegalensis</i> Lam. | HNM 1544 | Tigunguit | | L, S | Dry | Headaches | Infusion Maceration | Oral |
| <i>Lotus torulosus</i> (Chiov.) Fiori | HNM 1586 | Oumhallouss | | L | Dry | Gastrointestinal disorders; Asthma | Infusion Maceration | Oral |
| <i>Mimosa pigra</i> L. | HNM 2412 | | Gagnangi | L | Dry | Stomach pain ; Sexual impotence | Infusion Maceration | Oral |
| <i>Ptilostigma reticulatum</i> (DC.) Hochs | HNM 1553 | Tezzikre | Barkewi | L, W | Fresh | Haemorrhoids; Stomach disorders | Decoction | Oral |

| | | | | | | | | | |
|---|--------------|----------------|--------------|-------------|------------|---|-------------------------------|---------------|--|
| <i>Psoralea plicata</i> Delile. | HNM 2510 | Tatarite | | L | Dry | Diarrhea | Infusion | Oral | |
| <i>Senegalia senegal</i> (L.) Willd | HNM 2517 | Eyrwar | Patouki | L, E, G, P | Dry | Toothache; malaria; jaundice | Infusion Maceration | Oral | |
| <i>Senna tora</i> (L.) Roxb. | HNM 1540 | Evellejit | Youle/ Ulo | L | Dry | Inflammation ; Eye pain | Infusion | Oral | |
| <i>Senna italica</i> Mill. | HNM 1580 | Temat | Faladje | L | Dry | Diarrhea | Maceration | Oral | |
| <i>Vachellia ehrenbergiana</i> Hayne | HNM 2516 | | Bakanthili | L | Dry | Gastrointestinal; Asthma; Sexual weakness | Infusion | Oral | |
| <i>Vigna unguiculata</i> (L.) | Exotic plant | Adlegane | Niebe | L, F | Fresh | Anemia | Decoction | Oral | |
| <i>Vachellia nilotica</i> (L.) Willd. exDel. | HNM 2409 | Emour | Gawdi | L, F, E, S | Dry | Toothache; female infertility | Infusion | Oral | |
| <i>Vachellia seyal</i> Delile. | HNM 2411 | Essadra beidha | Bulbi | L | Dry | Diabetes; Aphrodisiac; Bronchial difficulties | Decoction | Oral | |
| <i>Vachellia tortilis</i> (Forssk.) Hayne | HNM 2518 | Etalh | Cilluki | L, E, F, W | Dry | Stomach disorders; diarrhea | Maceration | Oral | |
| Heliotropiaceae | | | | | | | | | |
| <i>Heliotropium ramosissimum</i> Sieber exDC. | HNM 1584 | Lihbaliyye | | L | Dry | Sore eyes; Headaches | Infusion | Oral | |
| Lithraceae | | | | | | | | | |
| <i>Lawsonia inermis</i> L. | Exotic Plant | Henne | Puudi | L | Dry | Rheumatism | Maceration Nature | Massage | |
| Malvaceae | | | | | | | | | |
| <i>Adansonia digitata</i> L. | HNM 2413 | Teydoun | Bokki | L, F, Br, S | Dry, Fresh | Bronchitis; rheumatism; body weakness; diabetes; dizziness; menstrual disorders; ulcers | Infusion Nature Maceration | Oral | |
| <i>Corchorus depressus</i> (L.) C. Chr. | HNM 2509 | Taghyittrab | Laalo | L | Dry | Diarrhea; dysentery | Maceration | Oral | |
| <i>Corchorus tridens</i> L. | HNM 1542 | Lsanth'or | Laalowalo | L | Dry | Anaemia; diarrhea; dysentery | Maceration | Oral | |
| <i>Grewia bicolor</i> Juss. | HNM 1532 | Imijij | Kellibalewi | L | Dry | Asthma; Eye inflammation | Maceration | Oral | |
| <i>Grewia tenax</i> (Forssk.) Fiori | HNM 1543 | Ligleyye | Kellindanewi | L | Dry | Digestive tonic; Loss of appetite | Maceration | Oral | |
| <i>Hibiscus sabdarifa</i> L. | Exotic Plant | Velere/ bissam | Folere | L | Dry, Fresh | Tiredness; Aphrodisiac | Maceration Decoction | Oral | |
| <i>Sida spinosa</i> L. | HNM 1536 | Wouznen' aaje | | L | Dry | Loss of appetite; cough | Infusion Maceration | Oral | |
| Meliaceae | | | | | | | | | |
| <i>Azadirachta indica</i> A. Juss | Exotic plant | Sidrayitkini | Nouvakini | L, F | Fresh | Malaria ; Tiredness; Skin irritation | Infusion Decoction | Oral, Massage | |
| <i>Khaya senegalensis</i> A. Juss | HNM 1533 | Tabaliya | Kahi | L, B, R, Se | Dry | Anaemia; Malaria; Intestinal worms; Jaundice | Infusion Decoction | Oral | |

Frequency of use of the most commonly used plants

Six species out of the total were reported as the most used by the healers (Fig. 8). The species *Ziziphus lotus* (FC = 75) and *Ziziphus mauritiana* (FC = 75) occupy the top percentage of use by the healers i.e. 12.36% each, followed by *Vachellia tortilis* (9.54% and FC = 73), *Adansonia digitata* (5.3% and FC = 74), *Gymnosporia senegalensis* (5.3%) and *Senegalia Senegal* (4.59% and FC = 75).

The relative frequency of citation (RFC)

The calculation of the relative frequency of citation (RFC) revealed that *Ziziphus lotus*, *Ziziphus mauritiana*, *Senegalia senegal* (RFC= 0.98), *Adansonia digitata*, *Gymnosporia senegalensis* (RFC= 0.97) and *Vachellia tortilis* (RFC= 0.96), have the greatest local importance (Tab. 2).

The range of FIV in the current study was 0.0008-0.65. *Commiphora africana* (A. Rich.) Engl had the highest value 0.65 followed by 0.49 for *Ziziphus lotus* (L.) Lam. and *Ziziphus mauritiana* Lam., 0.47 of *Gymnosporia senegalensis* Loes., Use value of *Lotus torulosus* (Chiov.) Fiori and *Psoralea plicata* Delile. was 0.0008 (Tab. 2).

Therapeutic use of medicinal plants according to the part used

Leaves are the most used part in traditional herbal medicine with a percentage of 56.34%, followed by fruits (20.10%) and then gum (9.78%). The other parts of the plant are rarely used (Fig. 9). The frequent use of leaves was also observed in other ethnobotanical studies (Dahmane et al., 2023; Belhaj & Zidane 2021; Jaadan et al., 2020; Jeddi et al., 2021; Kaboré et al., 2023; Mir et al., 2021; Ogbe et al., 2009; Rahmatullah et al., 2012). It could be justified by the ease and speed of harvesting and the simplicity of handling for the preparation of medicines (Salhi et al., 2010). As

well as preserving biodiversity. In addition, they are the site of photosynthesis and sometimes the storage of secondary metabolites (Bigendako-Polygenis & Lejoly, 1990).

Therapeutic use of medicinal plants according to the method of preparation

To facilitate the administration of the active ingredient, several therapeutic practices are utilized: infusion, cataplasm, decoction, powder, or maceration. We found that infusion is the most method of preparation used by these traditional practitioners (48%), followed by maceration (22%) and decoction (16%). Nevertheless, cataplasm is the less used (1%) (Fig. 10). Different results have been published by other researchers, have shown that decoction is the most used mode (Benaiche et al., 2019; Belhaj & Zidane, 2023; Kimpouni et al., 2019; Nguyen et al., 2020; Tchicaillat-Landou et al., 2018).

Therapeutic use of medicinal plants according to the mode of administration

Oral administration is the main mode (99.77%) (fig. 11). It was reported that between 30 and 65% of traditional medicines were administered orally (Adjanohoun & Aké-Assi, 1979; Adjanohoun et al., 1993; Bhandari et al., 2021; Benarba et al., 2015; Makambila, 2015; N'Guessan et al., 2009; Ouattara, 2006; Sangaré et al., 2012).

Therapeutic use of medicinal plants according to the conditions treated

results (Fig. 12) point that the majority of medicinal species are used in the treatment of digestive tract diseases with a percentage of 53.50%, followed by metabolic diseases (8%), osteoarticular diseases (6%), genitourinary diseases (6%), dermatological diseases (4%) and respiratory diseases (4%). These results are consistent with those of other researchers (Kimpouni et al., 2019).

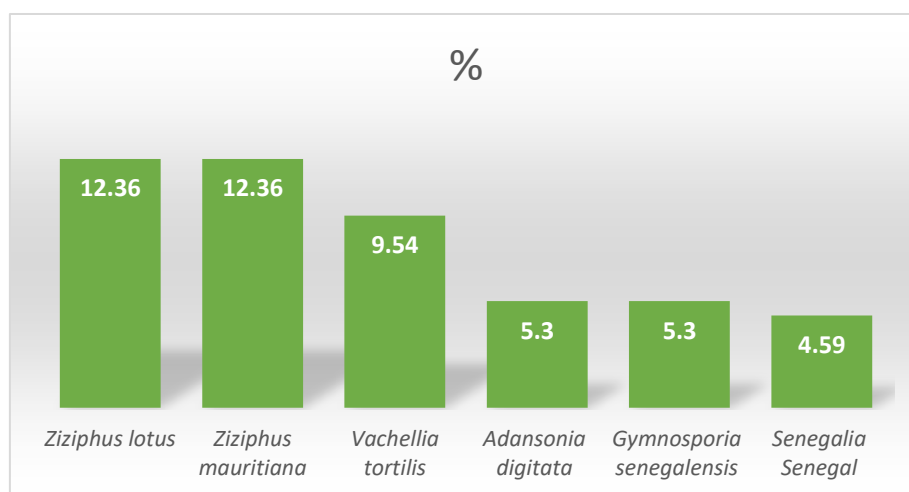


Fig. 8. The plants most used by healers in the five regions (Tiris Zemmour, Inchiri, Adrar, Brakna, and Trarza).

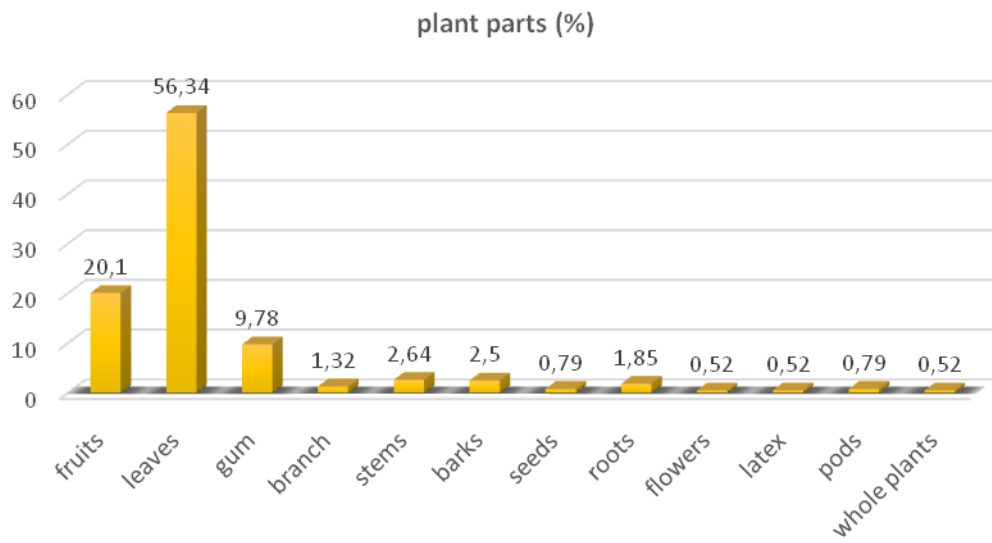


Fig. 9. Use of plant parts as crude drugs expressed in percentage (leaves, fruit, gum, stems, bark, seeds, roots, flowers, latex, pods and whole plants) in the five regions (Tiris Zemmour, Inchiri, Adrar, Brakna, and Trarza).

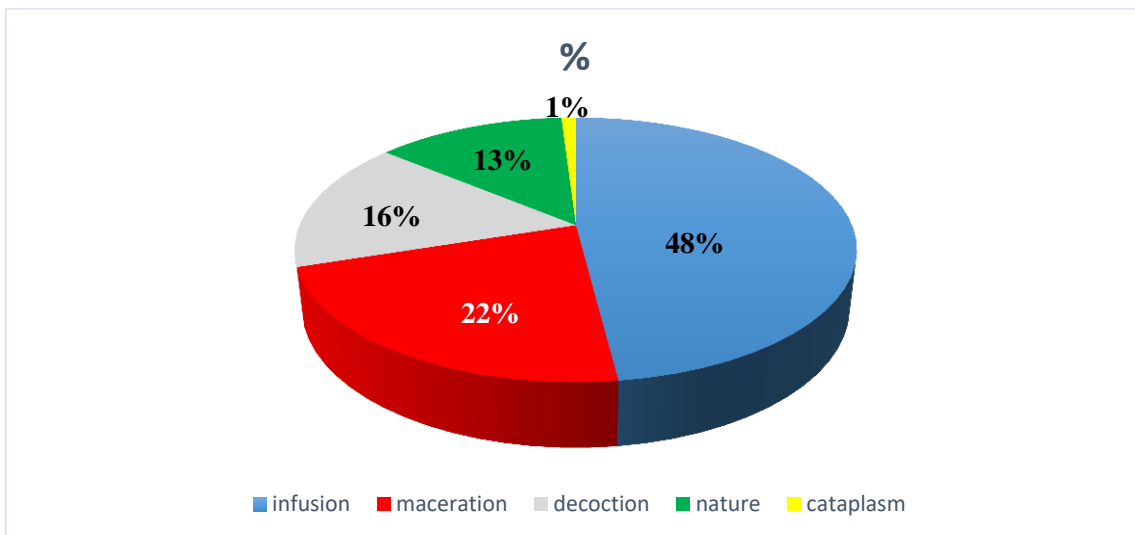


Fig. 10. Percentage use of plants by preparation method (infusion, maceration, decoction, nature and cataplasms) by five regions (Tiris Zemmour, Inchiri, Adrar, Brakna, and Trarza).

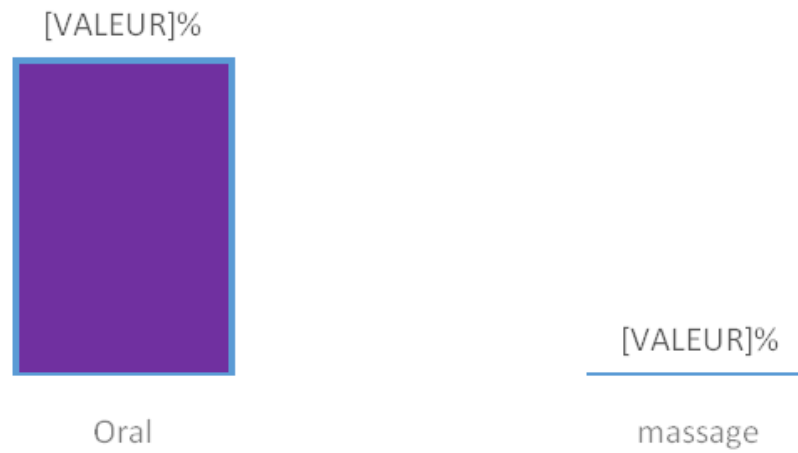


Fig. 11. Percentage of plant use according to the method of administration (oral, massage) in the regions studied (Tiris Zemmour, Inchiri, Adrar, Brakna, and Trarza).

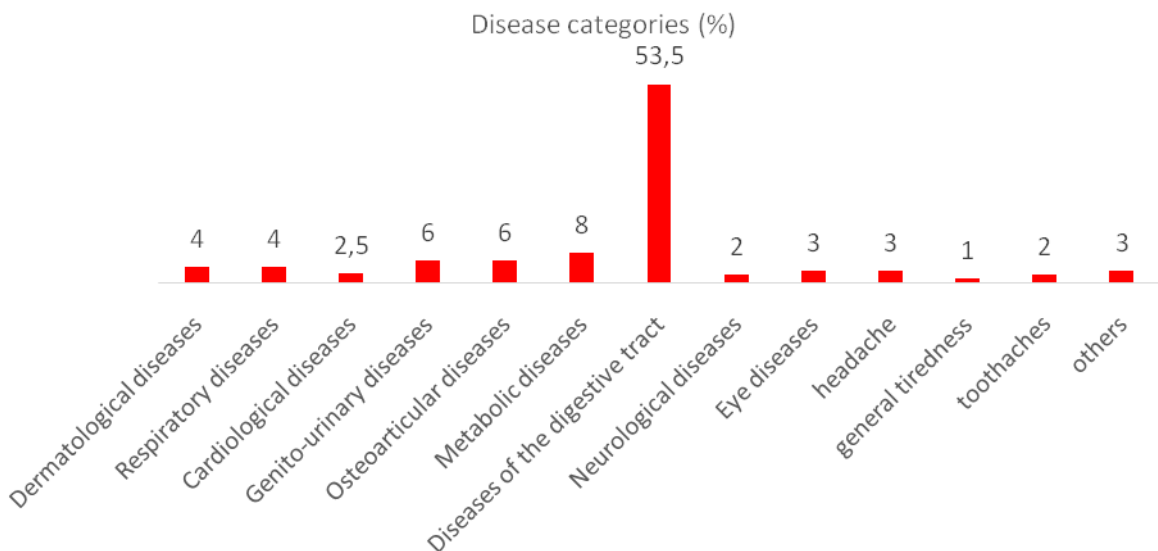


Fig. 12. Rate of diseases treated with medicinal plants (dermatological, respiratory, cardiological, genito-urinary, osteo-articulations, metabolic, digestive tract, ocular, headache, general fatigue, toothache and others in the five regions (Tiris Zemmour, Inchiri, Adrar, Brakna, and Trarza).

Table 2. Use values and Relative frequency citations for trees and shrub species in five regions (Tiris Zemmour, Adrar, Brakna, Inchiri, and Trarza).

| No | Scientific name | Medicinal uses | FC | RFC | FIV |
|----|---|---|----|-------|--------|
| 1 | <i>Achyranthes aspera</i> L. | Hypertension; gastrointestinal | 1 | 0.01 | 0.005 |
| 2 | <i>Aerva javanica</i> Juss. | Toothache; migraine | 5 | 0.06 | 0.03 |
| 3 | <i>Mangifera indica</i> L. | Body pain; Hypotension | 1 | 0.01 | 0.005 |
| 4 | <i>Sclerocary birrea</i> Hochst. | Gastrointestinal; Dysentery | 10 | 0.13 | 0.065 |
| 5 | <i>Calotropis procera</i> (Aiton) Dryand. | Bone and joint pain | 1 | 0.01 | 0.003 |
| 6 | <i>Leptadenia lanceolata</i> subsp. <i>lanceolata</i> | Stomach ache | 6 | 0.07 | 0.023 |
| 7 | <i>Leptadenia pyrotechnic</i> (Forssk.) Decne. | Jaundice; Constipation | 7 | 0.09 | 0.03 |
| 8 | <i>Phoenix dactylifera</i> L. | gastrointestinal disorders | 16 | 0.21 | 0.21 |
| 9 | <i>Stereospermum kunthianum</i> Cham. | Coughing; Stomach pains | 4 | 0.05 | 0.05 |
| 10 | <i>Anastatica hierochuntica</i> L. | Diabetes; Hypertension | 1 | 0.01 | 0.01 |
| 11 | <i>Commiphora africana</i> (A. Rich.) Engl | Toothache; Weakness; Bone and joint pain | 50 | 0.65 | 0.65 |
| 12 | <i>Boscia senegalensis</i> Lam. | Diabetes; Stomach ache; Aphrodisiac | 70 | 0.92 | 0.03 |
| 13 | <i>Capparis decidua</i> (Forssk.) Edgew. | Constipation | 17 | 0.22 | 0.07 |
| 14 | <i>Maerua crassifolia</i> Forskal. | Rheumatism; Loss of appetite | 29 | 0.38 | 0.12 |
| 15 | <i>Gymnosporia senegalensis</i> Loes. | Dysentery; intestinal worms | 36 | 0.47 | 0.47 |
| 16 | <i>Helianthemum lippii</i> (L.) Dum. Cours. | Inflammation | 2 | 0.02 | 0.02 |
| 17 | <i>Heliotropium ramosissimum</i> Sieber ex DC. | Inflammation | 1 | 0.01 | 0.01 |
| 18 | <i>Combretum aculeatum</i> Vent. | Haemorrhoids; Body weakness | 4 | 0.05 | 0.025 |
| 19 | <i>Combretum glutinosum</i> Perr. ex DC | Menstrual disorders, Constipation; Diabetes; Anaemia; Hepatitis | 4 | 0.05 | 0.025 |
| 20 | <i>Citrullus colocynthis</i> (L.) Schrad. | Menstrual disorders; Diarrhoea; Ashma; Anaemia; Constipation | 10 | 0.13 | 0.06 |
| 21 | <i>Momordica balsamina</i> L. | Inflammation | 2 | 0.02 | 0.01 |
| 22 | <i>Bauhinia rufescens</i> Lam. | Diuretic; fever | 9 | 0.11 | 0.007 |
| 23 | <i>Dalbergia melanoxyton</i> Guill. & Perr. | Migraine; Cough; Hernia | 2 | 0.02 | 0.001 |
| 24 | <i>Faidherbia albida</i> (Delile) A. Chev. | Eye inflammation; toothache; ulcers | 5 | 0.06 | 0.004 |
| 25 | <i>Indigofera senegalensis</i> Lam. | Headaches | 2 | 0.02 | 0.001 |
| 26 | <i>Lotus torulosus</i> (Chiov.) Fiori | Gastrointestinal disorders; Asthma | 1 | 0.01 | 0.0008 |
| 27 | <i>Mimosa pigra</i> L. | Stomach pain; Sexual impotence | 4 | 0.05 | 0.003 |
| 28 | <i>Piliostigma reticulatum</i> (DC.) Hochs | Haemorrhoids; Stomach disorders | 15 | 0.19 | 0.012 |
| 29 | <i>Psoralea plicata</i> Delile. | Diarrhoea | 1 | 0.01 | 0.0008 |
| 30 | <i>Senegalia senegal</i> (L.) Willd | Toothache; malaria; jaundice | 75 | 0.98 | 0.06 |
| 31 | <i>Senna tora</i> (L.) Roxb. | Inflammation; Eye pain | 7 | 0.09 | 0.005 |
| 32 | <i>Senna italica</i> Mill. | Constipation | 20 | 0.26 | 0.016 |
| 33 | <i>Vachellia ehrenbergiana</i> Hayne | Gastrointestinal | 30 | 0.39 | 0.024 |
| 34 | <i>Vigna unguiculata</i> (L.) | Anemia | 3 | 0.039 | 0.002 |
| 35 | <i>Vachellia nilotica</i> (L.) Willd. ex Del. | Toothache; female infertility | 3 | 0.039 | 0.002 |
| 36 | <i>Vachellia seyal</i> Delile. | Diabetes; Aphrodisiac; Bronchial difficulties | 20 | 0.26 | 0.016 |
| 37 | <i>Vachellia tortilis</i> (Forssk.) Hayne | Stomach disorders; diarrhea | 73 | 0.96 | 0.060 |
| 38 | <i>Lawsonia inermis</i> L. | Rheumatism | 1 | 0.01 | 0.01 |
| 39 | <i>Adansonia digitata</i> L. | Bronchitis; rheumatism; body weakness; diabetes; dizziness; menstrual disorders; ulcers | 74 | 0.97 | 0.13 |
| 40 | <i>Corchorus depressus</i> (L.) C. Chr. | Dysentery | 2 | 0.02 | 0.002 |
| 41 | <i>Corchorus tridens</i> L. | Anaemia; diarrhea; dysentery | 2 | 0.02 | 0.002 |
| 42 | <i>Grewia bicolor</i> Juss. | Asthma; Eye inflammation | 7 | 0.09 | 0.013 |

| | | | | | |
|----|---|---|----|-------|-------|
| 43 | <i>Grewia tenax</i> (Forssk.) Fiori | Digestive tonic; Loss of appetite | 3 | 0.039 | 0.005 |
| 44 | <i>Hibiscus sabdarifa</i> L. | Tiredness; Aphrodisiac | 1 | 0.01 | 0.001 |
| 45 | <i>Sida spinosa</i> L. | Loss of appetite; cough | 1 | 0.01 | 0.001 |
| 46 | <i>Azadirachta indica</i> A. Juss | Malaria; Tiredness; Skin irritation | 1 | 0.01 | 0.005 |
| 47 | <i>Khaya senegalensis</i> A.Juss | Anaemia; Malaria; Intestinal worms; Jaundice | 1 | 0.01 | 0.005 |
| 48 | <i>Moringa oleifera</i> Lam. | Skin irritation; anaemia; hypertension; sterility; diabetes; sexual dysfunction | 1 | 0.01 | 0.01 |
| 49 | <i>Boerhavia diffusa</i> L. | Inflammation; Sexual dysfunction; Influenza | 1 | 0.01 | 0.01 |
| 50 | <i>Rogeria adenophylla</i> Gay ex Delile | Inflammation | 1 | 0.01 | 0.01 |
| 51 | <i>Stipagrostis pungens</i> (Desf.) De Winter | Aphrodisiac; Diuretic | 1 | 0.01 | 0.01 |
| 52 | <i>Ziziphus lotus</i> (L.) Lam. | Diabetes; Intestinal worms; Gastrointestinal infection | 75 | 0.98 | 0.49 |
| 53 | <i>Ziziphus mauritiana</i> Lam | Diabetes; Intestinal worms; Gastrointestinal infection | 75 | 0.98 | 0.49 |
| 54 | <i>Mitragyna inermis</i> (Willd.) Kuntze | Rheumatism; Headaches; Pneumonia | 1 | 0.01 | 0.01 |
| 55 | <i>Tribulus terrestris</i> L. | Tingling in fingers, feet and toes, Muscle pain, Bronchitis | 1 | 0.01 | 0.01 |
| 56 | <i>Helianthemum lippii</i> (L.) Dum.Cours. | Inflammation | 1 | 0.01 | 0.01 |

FC = Frequency of citation; RFC= Relative frequency of citation; FIV= family importance value

Conclusion

This work is part of the project to promote of Mauritanian medicinal plants through ethnobotanical study. Despite drought and desertification, this country has significant plant resources that deserve to be better known for better use and protection. The ethnobotanical survey carried out in the five regions of Mauritania (Tiris Zemmour, Inchiri, Adrar, Brakna, and Trarza) enabled us to summarize a certain amount of information relating to the use of plants in traditional medicine. Traditional healers, whether Maures or Peulhs use the same plant species. Women, married people, and those with low levels of predominate among this category of healers. This type of medicine is essentially aimed at exploiting and developing local species. Diseases of the digestive and metabolic tracts are the most common in the recipes. Medicines in the form of plant drugs from the leaves are administered orally.

Declarations

List of abbreviations: WHO: World Health Organization; KS: Koranic school; PS: Primary school; SS: Secondary school; L: Leaf; Br: Branch; W: whole plant; B: Bark; R: Root; Fr: Fruit; S: Stem; P: Pod; G: Gum; La: Latex; Se: Seed; Fl: Flower.

Ethics Approval: Each participant gave their oral agreement before the survey.

Consent for publication: "Not applicable" in this section.

Availability of data and materials: The manuscript contains all the data.

Competing interests: The authors declare that there are no financial or non-financial conflicts of interest.

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Authors' contributions: Woury Aly Souleymane Sall: performed the survey and analyzed the results; Brahim Ould Elemine: performed the survey, Reviewing, discussing results, and editing; El Weilla Mohamed Mahmoud: performed the survey and analyzed the results, Mohamed Mahmoud Abidine: performed the survey and analyzed the results; Ahmedou Soulé: analyzed the results and editing; Ahmedou Vadel: Reviewing, discussing of results, and editing. All authors read and approved the final manuscript.

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References

- Abdullahi, A. A. (2011). Trends and Challenges of Traditional Medicine in Africa. *African Journal of Traditional, Complementary and Alternative Medicines*, 8(5), 115-123. <https://doi.org/10.4314/ajteam.v8i5S.5>
- Adjanohoun, J. E., Ahyi, M. R. A., Aké Assi, L., Alia, A. M., Amari, C. A., Gbile, Z. O., Johnson, C. L. A., Kakooko, Z. O., Lutakome, H. K., Morakinyo, O.,

- Mubiru, N. K., Ogwal-Okeng, J. W., & Sofowora, E. A. (1993). Traditional Medicine and Pharmacopoeia: Contribution to Ethnobotanical and Floristic Studies in Uganda. Scientific, Technical and Research Commission of the Organization of the African Unity (OAU/STRC), 433.
- Adjanohoun, J. E., Aké-Assi, L. (1979). Contribution au recensement de plantes médicinales de Côte d'Ivoire. Université d'Abidjan, Centre National de Floristique (CNF), 359.
- Alalwan, T. A., Alkhuzai, J. A., Jameel, Z., Mandeel, Q. A. (2019). Quantitative Ethnobotanical Study of some Medicinal Plants used by Herbalists in Bahrain. *Journal of Herbal Medicine*, 17(18), 100278. <https://doi.org/10.1016/j.hermed.2019.100278>
- Amigué, V.T., Arnason, J.T., Maquin, P., Cal, V., Vindas, P.S., Poveda, L. (2005) A consensus ethnobotany of the Q'eqchi' Maya of Southern Belize. *Economic Botany*, 59(1), 29–42
- Anyinam, C. (1995). Ecology and ethnomedicine. Exploring links between current environmental crisis and indigenous medical practices. *Social Science and Medicine*, 40, 321-329.
- Arezki, D., Ghemouri, G., Meddour, R., & Ouahiba, S. M. (2010). Ethnobotanical approach to medicinal plants in Kabylia (wilaya of Tizi Ouzou, Algeria). *Acta Horticulturae International Symposium on Medicinal and Aromatic Plants*, 425-434.
- Bekalo, T. H., Woodmatas, S. D., Woldemariam, Z. A. (2009). An ethnobotanical study of medicinal plants used by local people in the lowlands of Konta Special Woreda, southern nations, nationalities and peoples regional state, Ethiopia. *Journal of Ethnobiology and Ethnomedicine*, 5(1), 26. <https://doi.org/10.1186/1746-4269-5-26>
- Belhaj, S., Zidane, L. (2021). Ethnobotanical and ethnopharmacological study of medicinal plants used for the treatment of diseases of the digestive tract in the High Atlas Central of Morocco (North Africa). *Journal of Analytical Sciences and Applied Biotechnology*, 3(1), 3-1.
- Belhaj, S., Zidane, L. (2023). Ethnobotanical Study of Medicinal Plants Uses in the Treatment of Female Infertility at the High Atlas Central of Morocco. *Egyptian Journal of Botany*, 63(2), 535-549. <https://doi.org/10.21608/ejbo.2023.137055.1990>
- Benaiche, H., Bouredja, N., Alioua, A. (2019). Ethnobotanic study of medicinal plants used in Oran, Algeria. *Bangladesh Journal of Botany*, 48(4), 1163-1173. <https://doi.org/10.3329/bjb.v48i4.49072>
- Benamar, K., Koraichi, S. I., Benamar, S., Fikri-Benbrahim, K. (2023). Ethnobotanical study of medicinal plants used by the population of Ain Chkef (North central Morocco). *Ethnobotany Research and Applications*, 26. <https://doi.org/10.32859/era.26.4.1-23>
- Benarba, B. (2016). Medicinal plants used by traditional healers from South-west Algeria: An ethnobotanical study. *Journal of Intercultural Ethnopharmacology*, 5(4), 320. <https://doi.org/10.5455/jice.20160814115725>
- Benarba, B., Belabid, L., Righi, K., Bekkar, A. Amine, Elouissi, M., Khaldi, A., Hamimed, A. (2015). Ethnobotanical study of medicinal plants used by traditional healers in Mascara (North West of Algeria). *Journal of Ethnopharmacology*, 175(4), 626-637. <https://doi.org/10.1016/j.jep.2015.09.030>
- Bencheikh, N., Elbouzidi, A., Kharchoufa, L., Ouassou, H., Alami Merrouni, I., Mechchate, H., Es-safi, I., Hano, C., Addi, M., Bouhrim, M., Eto, B., Elachouri, M. (2021). Inventory of Medicinal Plants Used Traditionally to Manage Kidney Diseases in North-Eastern Morocco: Ethnobotanical Fieldwork and Pharmacological Evidence. *Plants*, 10(9), 1966. <https://doi.org/10.3390/plants10091966>
- Benkhignie, O., Zidane, L., Fadli, M., Elyacoubi, H., Rochdi, A., & Douira, A. (2010). Etude ethnobotanique des plantes médicinales dans la région de Mechraâ Bel Ksiri (Région du Gharb du Maroc). *Acta Botánica Barcinonensia*, 53, 191-216.
- Bhandari, P., Gurung, M. B., Subedi, C. K., Chaudhary, R. P., Basnet, K., Gurung, J., Uprety, Y., Neupane, A., Shresta, K. K. (2021). Traditional use of medicinal plants in the Chyangthapu-Phalaicha biological sub-corridor, Panchthar District, Kangchenjunga Landscape, Nepal. *Ethnobotany Research and Applications*, 22(25). <https://doi.org/10.32859/era.22.25.1-43>
- Bigendako-Polygenis, M., & Lejoly, J. (1990). La pharmacopée traditionnelle au Burundi. Pesticides et médicaments en santé animal. *Pres. Univ. Namur*, 425-442.
- Bonokwane, M. B., Lekhooa, M., Struwig, M., Aremu, A. O. (2022). Antidepressant Effects of South African Plants: An Appraisal of Ethnobotanical Surveys, Ethnopharmacological and Phytochemical Studies. *Frontiers in Pharmacology*, 13, 895286. <https://doi.org/10.3389/fphar.2022.895286>
- Cheikhoussef, A., Shapi, M., Matengu, K., Mu Ashekele, H. (2011). Ethnobotanical study of indigenous knowledge on medicinal plant use by traditional healers in Oshikoto region, Namibia. *Journal of Ethnobiology and Ethnomedicine*, 7(1), 10. <https://doi.org/10.1186/1746-4269-7-10>
- Dahmane, T., Kaci, Z., Hadj Mohamed, N., Abed, A., Mebkhout, F. (2023). Ethnobotanical Study of Spontaneous Medicinal Plants Gouraya's National Park (Bejaia- Algeria). *Egyptian Journal of Botany*, 63(3), 1083-1100. <https://doi.org/10.21608/ejbo.2023.202565.2294>
- Damintoti Karou, S., Tchacondo, T., Djikpo Tchibozo, M. A., Abdoul-Rahaman, S., Anani, K., Koudouvo, K., Batawila, K., Agbonon, A., Simporé, J., De Souza, C. (2011). Ethnobotanical study of medicinal plants used in the management of diabetes mellitus and hypertension in the Central Region of Togo. *Pharmaceutical Biology*, 49(12), 1286-1297. <https://doi.org/10.3109/13880209.2011.621959>
- Dibong, S., Mpondo, E., Ngoye, A., Kwin, M. (2011). Plantes médicinales utilisées par les populations Bassa de la région de Douala au Cameroun. *International Journal of Biological and Chemical Sciences*, 5(3). <https://doi.org/10.4314/ijbcs.v5i3.72227>
- Dougnon, T. V., Deguenon, E., Fah, L., Legba, B., Hounmanou, Y. M. G., Agbankpe, J., Amadou, A., Koudokpon, H., Fabiyi, K., Aniambossou, A., Assogba, P., Hounsa, E., De Souza, M., Avlessi, F., Dougnon, T. J., Gbaguidi, F., Boko, M., Bankole, H. S., Baba-Moussa, L. (2017). Traditional treatment of

- human and animal salmonellosis in Southern Benin: Knowledge of farmers and traditherapists. *Veterinary World*, 10(6), 580-592. <https://doi.org/10.14202/vetworld.2017.580-592>
- Eddouks, M., Maghrani, M., Lemhadri, A., Ouahidi, M.-L., Jouad, H. (2002). Ethnopharmacological survey of medicinal plants used for the treatment of diabetes mellitus, hypertension and cardiac diseases in the south-east region of Morocco (Tafilalet). *Journal of Ethnopharmacology*, 82(2-3), 97-103. [https://doi.org/10.1016/S0378-8741\(02\)00164-2](https://doi.org/10.1016/S0378-8741(02)00164-2)
- El Hafian, M., Benlandini, N., Elyacoubi, H., Zidane, L., & Rochdi, A. (2014). Étude floristique et ethnobotanique des plantes médicinales utilisées au niveau de la préfecture d'Agadir-Ida-Outanane (Maroc). *Journal of Applied Biosciences*, 81(1), 7198. <https://doi.org/10.4314/jab.v81i1.8>
- El Hilah, F., Akka, F. B., Dahmani, J., Belahbib, N., Lahcen, Z. (2015). Étude ethnobotanique des plantes médicinales utilisées dans le traitement des infections du système respiratoire dans le plateau central marocain. *Journal of Animal & Plant Sciences*, 25(2), 3886-3897.
- Essandoh, P. K., Aku Dali, G. L., Bryant, I. M. (2023). Medicinal plant use and integration of traditional healers into health care system: A case study at Ankasa Forest Reserve and catchment communities in Ghana. *Ethnobotany Research and Applications*, 26. <https://doi.org/10.32859/era.26.15.1-24>
- Eto, B. (2013). La phytothérapie, de l'utilisation traditionnelle aux dosage modernes des phytomédicaments: L'approche fonctionnelle. *Phytothérapie Européenne*, 19-23.
- Ferrier, J., Saciragic, L., Trakić, S., Chen, E. C. H., Gendron, R. L., Cuerrier, A., Balick, M. J., Redžić, S., Alikadić, E., Arnason, J. T. (2015). An ethnobotany of the Lukomir Highlanders of Bosnia & Herzegovina. *Journal of Ethnobiology and Ethnomedicine*, 11(1), 81. <https://doi.org/10.1186/s13002-015-0068-5>
- Gbekley, H. E., Karou, D. S., Gnoula, C., Tchacondo, T., Agbodeka, K., Anani, K., Tchacondo, T., Agbonon, A., Batawila, K., Simporé, J. (2015). Étude ethnobotanique des plantes utilisées dans le traitement du diabète dans la médecine traditionnelle de la région Maritime du Togo. *Pan African Medical Journal*, 20, 437-452. <https://doi.org/10.11604/pamj.2015.20.437.5660>
- Gedif, T., Hahn, H.J. (2003) The use of medicinal plants in self-care in rural central Ethiopia. *Journal of Ethnopharmacology*, 87(2-3), 155-161. [https://doi.org/10.1016/S0378-8741\(03\)00109-0](https://doi.org/10.1016/S0378-8741(03)00109-0)
- Ginko, E., Alajmovic Demirović, E., Šarić-Kundalić, B. (2023). Ethnobotanical study of traditionally used plants in the municipality of Zavidovići, BiH. *Journal of Ethnopharmacology*, 302, 115888. <https://doi.org/10.1016/j.jep.2022.115888>
- Gnagne, A. S., Camara, D., Fofie, N. B. Y., Bene, K., Zirih, G. N. (2017). Étude ethnobotanique des plantes médicinales utilisées dans le traitement du diabète dans le Département de Zouénoula (Côte d'Ivoire). *Journal of Applied Biosciences*, 113(1), 11257. <https://doi.org/10.4314/jab.v113i1.14>
- Heinrich, M., Gibbons, S. (2001). Ethnopharmacology in drug discovery: An analysis of its role and potential contribution. *Journal of Pharmacy and Pharmacology*, 53(4), 425-432. <https://doi.org/10.1211/0022357011775712>
- Irfan, M., Ullah, F., Ul Haq, I. (2023). Ethnomedicinal and Traditional uses of the Flora of District Lower Dir, Khyber Pakhtunkhwa, Pakistan. *Ethnobotany Research and Applications*, 26. <https://doi.org/10.32859/era.26.11.1-22>
- Jaadan, H., Akodad, M., Moumen, A., Baghour, M., Skalli, A., Ezrari, S., Belmalha, S. (2020). Ethnobotanical survey of medicinal plants growing in the region of « Oulad Daoud Zkhanine » (Nador Province), in Northeastern Morocco. *Ethnobotany Research and Applications*, 19. <https://doi.org/10.32859/era.19.39.1-12>
- Jeddi, M., Ouaritini, Z. B., Fikri-Benbrahim, K. (2021). Ethnobotanical study of medicinal plants in northern Morocco (Taounate): Case of Mernissa. *Ethnobotany Research and Applications*, 21. <https://doi.org/10.32859/era.21.35.1-23>
- Jiofack, T., Fokunang, C., Guedje, N., Kemeuze, V., Fongzossie, E., Nkongmeneck, B. A., Mapongmetsem, P. M., Tsabang, N. (2009). Ethnobotanical uses of some plants of two ethnoecological regions of Cameroon. *African Journal of Pharmacy and Pharmacology*, 3(13), 664-684.
- Kaido, T. L., Veale, D. J. H., Havlik, I., Rama, D. B. K. (1997). Preliminary screening of plants used in South Africa as traditional herbal remedies during pregnancy and labour. *Journal of Ethnopharmacology*, 55(3), 185-191. [https://doi.org/10.1016/S0378-8741\(96\)01499-7](https://doi.org/10.1016/S0378-8741(96)01499-7)
- Khalid A.E. Eisawi, Haytham H. Gibreel, Hong He, Tayyab Shaheen and Omer M. Abdalla (2022). Ethnobotanical Study of Medicinal Trees and Shrubs from the Rashad District of Southern Kordofan, Sudan. *Egyptian Journal of Botany*, 62 (2), 337-357.
- Emad H.E. Yasin. (2022). Ethnobotanical Study of Medicinal Trees and Shrubs from the Rashad District of Southern Kordofan, Sudan. *Egyptian Journal of Botany*. 62(2), 337-357. <https://doi.org/10.21608/ejb.2021.81264.1708>
- Kimpouni, V., Mamboueni, J. C., Tsoungould, F. G. M., Mikoko, E. N. (2019). Ethnobotanical and phytotherapeutic study from Kouni community of the sub-prefecture of Kayes (Bouenza – Congo). *Heliyon*, 5(8), e02007. <https://doi.org/10.1016/j.heliyon.2019.e02007>
- Mahwasane, S. T., Middleton, L., Boaduo, N. (2013). An ethnobotanical survey of indigenous knowledge on medicinal plants used by the traditional healers of the Lwamondo area, Limpopo province, South Africa. *South African Journal of Botany*, 88, 69-75. <https://doi.org/10.1016/j.sajb.2013.05.004>
- Makambila, M. T. (2015). Valorisation des plantes à potentialité antalgique utilisées au Congo. PhD Thesis. Université Marien Ngouabi, 40-45.
- Manuel, L., Bechel, A., Noormahomed, E. V., Hlshwayo, D. F., Madureira, M. D. C. (2020). Ethnobotanical study of plants used by the traditional healers to treat malaria in Mogovolas district, northern Mozambique. *Heliyon*, 6(12), e05746. <https://doi.org/10.1016/j.heliyon.2020.e05746>

- Mechaala, S., Bouatrous, Y., Adouane, S. (2022). Traditional knowledge and diversity of wild medicinal plants in El Kantara's area (Algerian Sahara gate): An ethnobotany survey. *Acta Ecologica Sinica*, 42(1), 33-45. <https://doi.org/10.1016/j.chnae.s.2021.01.007>
- Mehdioui, R., Kahouadji, A. (2007). Etude ethnobotanique auprès de la population riveraine de la forêt d'Amsittène: Cas de la Commune d'Imi n'Tlit (Province d'Essaouira). *Bulletin de l'Institut Scientifique*, 19, 11-20.
- Molares, S., Ladio, A. (2009) Ethnobotanical review of the Mapuche medicinal flora: use patterns on a regional scale. *Journal of Ethnopharmacology*, 122(2), 251-260. <https://doi.org/10.1016/j.jep.2009.01.003>
- Mhlongo, L. S., Van Wyk, B.-E. (2019). Zulu medicinal ethnobotany: New records from the Amandawe area of KwaZulu-Natal, South Africa. *South African Journal of Botany*, 122, 266-290. <https://doi.org/10.1016/j.sajb.2019.02.012>
- Mokgobi, M. G. (2014). Understanding traditional African healing. *Afr J Phys Health Educ Recreat Dance*, 20(2), 24-34.
- Nesrine, B., Rajaa, R., Sakina, N. (2022). Enquête ethnobotanique et inventaire des plantes médicinales utilisées dans le traitement des maladies dermatologiques dans la ville d'Ain Temouchent. *Journal of Applied Biosciences*, 170, 17704-17719.
- Ngbolua, K. N., Molongo, M. M., Libwa, M. T. B., Amogu, J. J. D., Kutshi, N. N., Masengo, C. A. (2021). Enquête ethnobotanique sur les plantes sauvages alimentaires dans le Territoire de Mobayi-Mbongo (Nord-Ubangi) en République Démocratique du Congo. *Rev. Mar. Sci. Agron. Vég*, 9(2), 259-265.
- Nguyen, X.-M.-A., Bun, S.-S., Ollivier, E., Dang, T.-P.-T. (2020). Ethnobotanical study of medicinal plants used by K'Ho-Cil people for treatment of diarrhea in Lam Dong Province, Vietnam. *Journal of Herbal Medicine*, 19(100320). <https://doi.org/10.1016/j.herm.ed.2019.100320>
- Ogbe, F. M. D., Eruogun, O. L., Uwagboe, M. (2009). Plants used for female reproductive health care in oredo local government area, Nigeria. *Journal of Scientific Research and Essay*, 4(3), 120-130.
- Ouattara, D. (2006). Contribution à l'inventaire des plantes médicinales significatives utilisées dans la région de Divo (Sud forestier de la Côte d'Ivoire) et à la diagnose du poivrier de Guinée: *Xilopia* a Ethiopia (Dunal) A. Rich. (Annonaceae). PhD Thesis. Université de Cocody-Abidjan, Côte- d'Ivoire, 184.
- Ould Mohamed vall, A. (2009). Contribution à l'étude des plantes médicinales de mauritanie. *Ann. Univ. Lomé (Togo)*, 9-27.
- Petrovska, B. (2012). Historical review of medicinal plants' usage. *Pharmacognosy Reviews*, 6(11), 1. <https://doi.org/10.4103/0973-7847.95849>
- Rahmatullah, M., Hossan, S., Kahtun, A., Seraj, S., Jahan, R. (2012). Medicinal plants used by various tribes of Bangladesh for treatment of malaria. *Malaria Research and Treatment*, 371-798.
- Salhi, S., Fadli, M., Zidane, L., Douira, A. (2010). Etudes floristique et ethnobotanique des plantes médicinales de la ville de Kénitra (Maroc). *Lazaroa*, 31, 133-143. https://doi.org/10.5209/rev_LAZA.2010.v31.9
- Sangaré, M. M., Sina, H., Dougnon, J., Bayala, B., Ategbro, J. M., & Dramane, K. L. (2012). Etude ethnobotanique des plantes hépatotropes et de l'usage traditionnel de *Gomphena celosioides* Mart. (Amaranthaceae) au Bénin. *International Journal of Biological and Chemical Sciences*, 6(6), 5008-5021.
- Saroya, A. S. (2011). *Herbalism: Phytochemistry and Ethnopharmacology*. Science Publishers, New Hampshire, 8-12.
- Süntar, I. (2020). Importance of ethnopharmacological studies in drug discovery: Role of medicinal plants. *Phytochemistry Reviews*, 19, 1199-1209.
- Tabuti, J. R. S., Lye, K. A., Dhillion, S. S. (2003). Traditional herbal drugs of Bulamogi, Uganda: Plants, use and administration. *Journal of Ethnopharmacology*, 88(1), 19-44. [https://doi.org/10.1016/S0378-8741\(03\)00161-2](https://doi.org/10.1016/S0378-8741(03)00161-2)
- Tchicailat-Landou, M., Petit, J., Gaiani, C., Miabangana, E. S., Kimbonguila, A., Nzikou, J.-M., Scher, J., Matos, L. (2018). Ethnobotanical study of medicinal plants used by traditional healers for the treatment of oxidative stress-related diseases in the Congo Basin. *Journal of Herbal Medicine*, 13, 76-90. <https://doi.org/10.1016/j.hermed.2018.05.002>
- Thirumalai, T., Kelumalai, E., Senthilkumar, B., David, E. (2009). Ethnobotanical Study of Medicinal Plants used by the Local People in Vellore District, Tamilnadu, India. *Ethnobotanical Leaflets*, 13, 1302-1311.
- Vall, A. O. M., Boumediana, A. O. I., Soule, A. O., Gueye, M., Labat, J. N. (2011). Contribution to the study of the flora of Mauritania: 1—Evaluation of plant biodiversity of Assaba (Açaba). *Bulletin de l'Institut Scientifique: Section Sciences de la Vie*, 33(2), 53-64.
- Vall, A. O. M., Taleb, M. S., Abed, N. E., Abdellahi, M. L. C., Kokou, K., Morou, B. (2015). Contribution to the study of the flora of Mauritania. 2. Biodiversity and ecosystem importance of the Fabaceae. *Bulletin de l'Institut Scientifique: Section Sciences de la Vie*, 30, 29-37.
- Vitalini, S., Iriti, M., Puricelli, C., Ciuchi, D., Segale, A., Fico, G. (2013) Traditional knowledge on medicinal and food plants used in Val San Giacomo (Sondrio, Italy) - An alpine ethnobotanical study. *Journal of Ethnopharmacology*, 145(2), 517-529. <https://doi.org/10.1016/j.jep.2012.11.024>
- Yaseen, G., Ahmad, M., Sultana, S., Alharrasi, A. S., Hussain, J., Zafar, M., & Rehman, S.-U.-. (2015). Ethnobotany of Medicinal Plants in the Thar Desert (Sindh) of Pakistan. *Journal of Ethnopharmacology*, 163, 43-59. <https://doi.org/10.1016/j.jep.2014.12.053>
- Yebouk, C. (2021). Approche Ethnobotanique de la Flore d'Intérêt Médicinal, Cosmétique et Artisanale dans la Wilaya d'Adrar (Mauritanie) [DOCTORAT EN SCIENCES]. Université Abdelmalek Essaâdi.